Chapter 3

Results & Discussion

3.0 Result and Discussion

The determination of sodium lauryl sulfate was carried out for 14 different types of household detergents. These 14 detergents consist of textile detergent, dishwasher and different kinds of cleaning agents. The determination of the sodium lauryl sulfate in these samples were carried out by two different methods:

1. Two phase Titrimetric method
2. Spectrophotometric method

The two-phase titrimetric method is based on the use of methyl yellow as indicator for the end-point of a titration with benzethonium chloride. The colour change in the chloroform layer is from pink to yellow.

The spectrophotometric method is based on the use of Azure A to form a complex with sodium lauryl sulfate, which is extracted from aqueous layer to chloroform layer. Colorimetric determination of the Azure A in chloroform phase was done in order to determine the amount of sodium lauryl sulfate in the samples.

3.1 Detergents Sample

There are 14 house hold detergents that being selected for this project. Some of them are the leading brand cleaning agents in Malaysia while the others are non-branded. The samples are listed as below:

1. Max Kleen 9 dishwasher
2. Sunlight dishwasher
3. Dynamo textile detergent
4. Eeko textile detergent
5. Dettol handsoap
6. Kiwi floor cleaner
7. Glassex glass cleaner
8. Ajax fabuloso floor cleaner
9. Jiff cleaner
10. Amway liquid organic cleaner
11. Harpic toilet cleaner
12. Prokleen cleaner
13. Magic clean cleaner
14. 99 car wash cleaner

Most of these detergents do not carry the list of ingredients in their label probably due to the fact that there is no regulations for detail ingredients to be listed in the label of these detergents.

3.2 Two-phase Titrimetric Method

In order to prepare the samples for the determination of sodium lauryl sulfate by two-phase titrimetric method, the samples are pre-treated by acidification with hydrochloric acid followed by heating until the oil from the sample solidified and separated.

The treated samples which are free from any oil and solid will be added to a fixed volume of chloroform result in the formation of a two-phase medium. The solution will be titrated with cationic active benzethonium chloride standard solution using methyl yellow as the indicator. A sharp end point will be obtained with the colour change from pink to yellow.

It is very important that prior to the determination of sodium lauryl sulfate in the sample, the purity of the analytical grade sodium lauryl sulfate and benzethonium chloride have to be determined. This is to ensure that the error in the preparation of the standard sodium lauryl sulfate and standardization of benzethonium chloride is minimized.

The purity of benzethonium chloride was determined by titrating with acetous perchloric acid using bromophenol blue as indicator. The acetous perchloric acid is in turn standardized by the non aqueous titration with standard potassium hydrogen phthalate solution with bromophenol blue as indicator.

Standardization of Acetous Perchloric Acid

Table 3: Volume of acetous perchloric acid for the blank titration

Volume of titrant/ml	Blank titration		
	1	2	3
End value	0.10	0.20	0.30
Initial value	0.00	0.10	0.20
Net value	0.10	0.10	0.10

Average $= \frac{0.10 + 0.10 + 0.10}{3}$

$= 0.10$ ml

Table 4: Weight of potassium hydrogen phthalate

Sample	1	2	3
Weight of potassium hydrogen phthalate/g	0.4523	0.4516	0.4509

Table 5: Volume of acetous perchloric acid for the titration of potassium hydrogen phthalate

Volume of titrant/ml	Titration of potassium hydrogen phthalate		
	1	2	3
End value	21.65	21.65	21.6
Initial value	0.00	0.00	0.00
Net value	21.65	21.65	21.6

Molarity of acetous perchloric acid = $\frac{W}{204.23 \times (V - V_o)}$

Where W = Weight of potassium hydrogen phthalate/mg

V_o = Volume of acetous perchloric acid for the blank titration/ml

V = Volume of acetous perchloric acid for the titration of potassium hydrogen phthalate/ml

Sample 1:

Molarity of acetous perchloric acid = $\frac{0.4523}{204.23 \times (21.65 - 0.01)}$

= 0.1028 M

Sample 2:

Molarity of acetous perchloric acid = $\frac{0.4516}{204.23 \times (21.65 - 0.01)}$

= 0.1026 M

Sample 3:

Molarity of acetous perchloric acid = $\frac{0.4509}{204.23 \times (21.60 - 0.01)}$

= 0.1027 M

Average molarity of acetous perchloric acid = $\frac{0.1028 + 0.1026 + 0.1027}{3}$

= 0.1027 M

Determination of the purity of Benzethonium Chloride

Table 6: Volume of acetous perchloric acid for the blank titration

Volume of titrant/ml	Blank titration		
	1	2	3
End value	0.10	0.20	0.30
Initial value	0.00	0.10	0.20
Net value	0.10	0.10	0.10

Average = $\frac{0.10 + 0.10 + 0.10}{3}$

= 0.10 ml

Table 7: Weight of benzethonium chloride used

Sample	1	2	3
Weight of benzethonium chloride/g	1.0006	1.0077	1.0023

Table 8: Volume of acetous perchloric acid for the titration of benzethonium chloride

Volume of titrant/ml	Titration of benzethonium chloride		
	1	2	3
End value	21.00	21.05	21.00
Initial value	0.00	0.00	0.00
Net value	21.00	21.05	21.00

$$\% \text{ purity of benzethonium chloride} = \frac{(V - V_0) \times M \times 44.81}{m}$$

Where V_o = Volume of acetous perchloric acid for the blank titration/ml

V = Volume of acetous perchloric acid for the titration of benzethonium chloride/ml

M = Molarity of perchloric acid/M

m = Weght of benzethonium chloride//g

Sample1:

$$\% \text{ purity of benzethonium chloride} = \frac{(21.00 - 0.01) \times 0.1027 \times 44.81}{1.0006}$$

$$= 96.12\ \%$$

Sample 2:

$$\% \text{ purity of benzethonium chloride} = \frac{(21.05 - 0.01) \times 0.1027 \times 44.81}{1.0077}$$

$$= 95.67\ \%$$

Sample 3:

$$\% \text{ purity of benzethonium chloride} = \frac{(21.00 - 0.01) \times 0.1027 \times 44.81}{1.0023}$$

$$= 95.96\ \%$$

$$\text{Average \% purity of benzethonium chloride} = \frac{96.12 + 95.67 + 95.96}{3}$$

$$= 95.92\ \%$$

Determination of the purity of sodium lauryl sulfate (SLS)

Purity of SLS was determined by using 0.005 M benzethonium chloride and methyl yellow to do the titration against the SLS solution.

0.005 M standard benzethonium chloride solution was prepared as followed:

Weight of benzethonium chloride = 2.3449 g

Purity of benzethonium chloride = 95.92 %

Actual weight of benzethonium chloride = $\frac{2.3449 \times 95.92}{100}$

= 2.2492 g

Hence, 2.2492 g benzethonium chloride diluted to 1 L obtain a concentration of:

$\frac{2.2492\ g}{448.1 \times 1\ L}$ = 0.005 M

Sample 1

Weight of sodium lauryl sulfate = 0.5020 g

Table 9: Volume of benzethonium chloride for the titration of SLS

Volume of titrant/ml	Titation Of SLS		
	1	2	3
End value	33.40	33.35	33.40
Initial value	0.00	0.00	0.00
Net value	33.40	33.35	33.40

$$\text{Average} = \frac{33.40 + 33.35 + 33.40}{3}$$

$$= 33.38 \text{ ml}$$

$$\text{Purity of SLS} = \frac{V \times (M / 1000) \times W \times 100}{m \times w \times (25 \text{ ml} / 250 \text{ ml})}$$

$$= \frac{V \times M \times W}{m \times w}$$

Where V = Volume of benzethonium chloride (ml)

M = Molarity of benzethonium chloride (M) =0.005 M

W = Molecular weight of SLS (g/mol) =288.38

m = Mol of benzethonium chloride by 1 mol of SLS =1

w = Weight of sample (g)

Purity of SLS $= \frac{V \times M \times W}{m \times w}$

$= \frac{33.38 \times 0.005 \times 288.38}{1 \times 0.5020}$

$= 95.88\ \%$

Sample 2

Weight of sodium lauryl sulfate = 0.5009 g

Table 10: Volume of benzethonium chloride for the titration of SLS

Volume of titrant/ml	Titation Of SLS		
	1	2	3
End value	33.35	33.35	33.40
Initial value	0.00	0.00	0.00
Net value	33.35	33.35	33.40

Average $= \frac{33.35 + 33.35 + 33.40}{3}$

$= 33.37$ ml

Purity of SLS $= \frac{V \times (M / 1000) \times W \times 100}{m \times w \times (25\ ml / 250\ ml)}$

$= \frac{V \times M \times W}{m \times w}$

Where V = Volume of benzethonium chloride (ml)

M = Molarity of benzethonium chloride (M) =0.005 M

W = Molecular weight of SLS (g/mol) =288.38

m = Mol of benzethonium chloride by 1 mol of SLS =1

w = Weight of sample (g)

$$\text{Purity of SLS} = \frac{V \times M \times W}{m \times w}$$

$$= \frac{33.37 \times 0.005 \times 288.38}{1 \times 0.5009}$$

$$= 96.05\ \%$$

Sample 3

Weight of sodium lauryl sulfate = 0.5002 g

Table 11: Volume of benzethonium chloride for the titration of SLS

Volume of titrant/ml	Titation Of SLS		
	1	2	3
End value	33.35	33.35	33.35
Initial value	0.00	0.00	0.00
Net value	33.35	33.35	33.35

$$\text{Average} = \frac{33.35 + 33.35 + 33.35}{3}$$

$$= 33.35\ \text{ml}$$

$$\text{Purity of SLS} = \frac{V \times (M / 1000) \times W \times 100}{m \times w \times (25\ ml / 250\ ml)}$$

$$= \frac{V \times M \times W}{m \times w}$$

Where V = Volume of benzethonium chloride (ml)

M = Molarity of benzethonium chloride (M) =0.005 M

W = Molecular weight of SLS (g/mol) =288.38

m = Mol of benzethonium chloride by 1 mol of SLS =1

w = Weight of sample (g)

$$\text{Purity of SLS} = \frac{V \times M \times W}{m \times w}$$

$$= \frac{33.35 \times 0.005 \times 288.38}{1 \times 0.5002}$$

$$= 96.14\ \%$$

$$\text{Average \% purity of sodium lauryl sulfate} = \frac{95.88 + 96.05 + 96.14}{3}$$

$$= 96.02\ \%$$

3.2.4 Determination of SLS in samples

The formula that used to determine the sodium lauryl sulfate (SLS) in the samples is the same formula that used for the determination of the purity of sodium lauryl sulfate:

$$\text{Purity of SLS} = \frac{V \times (M / 1000) \times W \times 100}{m \times w \times (25\ ml / 250\ ml)}$$

$$= \frac{V \times M \times W}{m \times w}$$

Where V = Volume of benzethonium chloride (ml)

M = Molarity of benzethonium chloride (M) =0.005 M

W = Molecular weight of SLS (g/mol) =288.38

m = Mol of benzethonium chloride by 1 mol of SLS =1

w = Weight of sample (g)

Description of the procedure for calculating the percentage purity of SLS in detergents.

If V is the volume of benzethonium chloride used in the titration with sodium lauryl sulfate.

Hence the number of mole of benzethonium chloride used

$$= \frac{MV}{1000} \text{ moles}$$ (M = molarity of benzethonium chloride)

If m mole of benzethonium chloride titrated with 1 mole of SLS, then the number of mole of SLS

$$= \frac{MV}{1000 \times m}$$

The weight of SLS in 25 ml of sample solution

$$= \frac{MV}{1000 \times m} \times W$$

where W = molecular weight of SLS

The amount of SLS in the original 250 ml sample solution

$$= \frac{MV}{1000 \times m} \times \frac{W}{(25/250)}$$

The percentage of SLS in samples is therefore

$$= \frac{MVW}{1000 \times m\ (25/250)} \times \frac{1}{w} \times 100\%$$

where w = weight of sample used

The results obtained from the two-phase titrimetric method are given in Tables 12, 13, and 14. Analysis of average SLS content in these household detergents revealed that the majority of the samples contained between 0 to 4% of SLS content in their formulation. Four of the products namely Harpic toilet cleaner, Prokleen cleaner, Magic clean detergent and 99 car wash cleaner were found to have negligible amount of SLS in their products. On the other hand, another four of the products analysed, namely Max kleen 9 dishwasher, Sunlight dishwasher, Dynamo detergent and Dettol hand soap were found to have SLS contents of 3.434%, 4.0685%, 2.384% and 1.300%, respectively. The result of these four products clearly indicated that the amount of SLS content is well above the 1% level recommended for detergents and other cleaning agent for prolong usage. It was also noted that all of the floor detergent analysed, for example, Kiwi floor cleaner, Ajax Fabuloso floor cleaner, Jiff cleaner and Amway LOC as well as Glassex glass cleaner were found to have the recommended amount of SLS in their samples.

Table 12: Determination of sodium lauryl sulfate in some detergent products by titrimetric method

No.	Sample	Analysis 1						
		Vol. Of Titrant (ml)				Weight of sample (g)	SLS (%)	SLS (%)*
		1	2	3	Average			
1	Max Kleen 9 dishwasher	23.85	23.80	23.80	23.82	10.0012	3.4340	0.6868
2	Sunlight dishwasher	28.25	28.20	28.20	28.22	10.0005	4.0685	0.8137
3	Dynamo detergent	16.50	16.55	16.55	16.53	10.0003	2.3840	0.4768
4	Eeko detergent	3.75	3.75	3.70	3.73	10.0000	0.5385	0.1077
5	Dettol handsoap	9.00	9.00	9.05	9.02	10.0013	1.3005	0.2601
6	Kiwi floor cleaner	2.70	2.75	2.75	2.73	10.0007	0.3940	0.0788
7	Glassex glass cleaner	2.00	2.00	2.00	2.00	10.0020	0.2883	0.0577
8	Ajax fabuloso floor cleaner	0.70	0.70	0.75	0.72	10.0001	0.1038	0.0208
9	Jiff cleaner	0.35	0.35	0.30	0.32	10.0013	0.0460	0.0092
10	Amway liquid organic cleaner	0.20	0.20	0.20	0.20	9.9976	0.0288	0.0058
11	Harpic toilet cleaner	0.00	0.00	0.00	0.00	10.0010	0.0000	0.0000
12	Prokleen cleaner	0.00	0.00	0.00	0.00	10.0017	0.0000	0.0000
13	Magic clean cleaner	0.00	0.00	0.00	0.00	10.0023	0.0000	0.0000
14	99 car wash cleaner	0.00	0.00	0.00	0.00	9.9987	0.0000	0.0000

SLS %* - The percentage of Sodium Lauryl Sulfate for the titrimetric method is adjusted to make comparison with the spectrophotometric method

Table 13: Determination of sodium lauryl sulfate in some detergent products by titrimetric method

No.	Sample	Analysis 2						
		Vol. Of Titrant (ml)				Weight of sample (g)	SLS (%)	SLS (%)*
		1	2	3	Average			
1	Max Kleen 9 dishwasher	24.00	24.05	24.05	24.03	10.0015	3.4645	0.6929
2	Sunlight dishwasher	28.70	28.70	28.70	28.70	10.0012	4.1380	0.8276
3	Dynamo detergent	16.00	16.05	16.05	16.03	10.0007	2.3115	0.4623
4	Eeko detergent	3.60	3.60	3.60	3.60	10.0009	0.5190	0.1038
5	Dettol handsoap	9.00	8.95	8.95	8.97	10.0020	1.2930	0.2586
6	Kiwi floor cleaner	2.60	2.60	2.60	2.60	10.0010	0.3745	0.0749
7	Glassex glass cleaner	2.10	2.05	2.05	2.07	10.0029	0.2979	0.0596
8	Ajax fabuloso floor cleaner	0.60	0.65	0.60	0.62	9.9987	0.0889	0.0178
9	Jiff cleaner	0.30	0.35	0.35	0.33	10.0020	0.0475	0.0095
10	Amway liquid organic cleaner	0.20	0.20	0.25	0.22	10.0015	0.0312	0.0063
11	Harpic toilet cleaner	0.00	0.00	0.00	0.00	10.0007	0.0000	0.0000
12	Prokleen cleaner	0.00	0.00	0.00	0.00	10.0023	0.0000	0.0000
13	Magic clean cleaner	0.00	0.00	0.00	0.00	10.0000	0.0000	0.0000
14	99 car wash cleaner	0.00	0.00	0.00	0.00	10.0009	0.0000	0.0000

SLS %* - The percentage of Sodium Lauryl Sulfate for the titrimetric method is adjusted to make comparison with the spectrophotometric method

Table 14: Average value of % sodium lauryl sulfate in the 14 samples determined by titrimetric method

No.	Sample	Analysis 1 SLS (%)*	Analysis 2 SLS (%)*	Average % SLS	Repeatability (%)*
1	Max Kleen 9 dishwasher	0.6868	0.6929	0.6899	0.8843
2	Sunlight dishwasher	0.8137	0.8276	0.8207	1.6938
3	Dynamo detergent	0.4768	0.4623	0.4696	3.0881
4	Eeko detergent	0.1077	0.1038	0.1058	3.6879
5	Dettol handsoap	0.2601	0.2586	0.2593	0.5784
6	Kiwi floor cleaner	0.0788	0.0749	0.0769	5.0748
7	Glassex glass cleaner	0.0577	0.0596	0.0587	3.2396
8	Ajax fabuloso floor cleaner	0.0208	0.0178	0.0193	15.5440
9	Jiff cleaner	0.0092	0.0095	0.0094	3.2086
10	Amway liquid organic cleaner	0.0058	0.0063	0.0061	8.1967
11	Harpic toilet cleaner	0.0000	0.0000	0.0000	0.0000
12	Prokleen cleaner	0.0000	0.0000	0.0000	0.0000
13	Magic clean cleaner	0.0000	0.0000	0.0000	0.0000
14	99 car wash cleaner	0.0000	0.0000	0.0000	0.0000

* The repeatability of the determination is calculated by dividing the difference between the results of 2 determination carried out on the same sample simultaneously or in rapid succesion by the same analyst using the same apparatus by average

3.3 Spectrophotometric Method

In order to determine the reliability of the results obtained from the classical titrimetric method, the spectrophotometric method analysis of SLS with the use of an UV/visible spectrophotometer was also carried out. Similar to the titrimetric method, sample treatment is necessary in order to prepare samples suitable for UV-visible determination. The samples are acidified with hydrochloric acid and heated in order to isolate the oil and solidified fat from the samples of these detergents. The SLS content was extracted from the sample solution by liquid-liquid extraction procedure with chloroform. Blank solution was prepared by the addition of cationic surfactant which in this case, benzethonium chloride during the extraction. After the addition of the ionic dye namely Azure A to both the blank and sample solution, the absorbance of the solutions were measured at the wavelength maximum of 637 nm (Figure 10) using a UV-visible spectrophotometer. The absorbance of the blank is subtracted from the absorbance of the sample. The amount of SLS in the samples was determined by using a calibration graph of absorbance versus concentration of a series of standard SLS solution prepared earlier. Figure 11a and 11b showed the calibration graph of absorbance versus concentration of the SLS standards, together with the linear regression analysis of the graph. The percentage of SLS in the 14 household detergents determined by spectrophotometric method are given in Tables 16, 17 and 18. A comparison of the results in table 14 and 18 revealed that the contents of SLS determined by the spectrophotometric method do not differ significantly from that obtained from the classical titrimetric method, although an improve repeatability was observed in the case of spectrophotometric method.

One of the factor which affect the reliability and repeatability of the method would be the interference caused by the presence of other ionic surfactants such as alkylbenzene sulfonate, alkane sulfonate, hydroxysulfates, alkylphenol sulfate, fatty alcohol methoxy and ethoxysulfates, dialkylsulfosuccinates and other material containing the hydrophilic functional group. It was therefore necessary to assume that the samples used in this analysis contained only one type of anionic surfactants, which is probably the case for most commercial product formulations.

In contrast, low molecular mass sulfonates present as hydrotropes such as toluene and xylene do not interfere when present in concentration of up to 15 % relative to the active ingredient. Soap, urea and salts of ethylenedinitril tetraacetic acid also do not interfere. Similarly the presence of inorganic components in detergent formulations, such as sodium chloride, sulfates, borates, tripolyphosphates, silicates, etc., are found to be inactive and will not affect the results.

In the case of spectrophotometric method where the use of calibration graph is important, the limit of detection for the method was also determined by using the results from the linear regression analysis of the calibration curve. The limit of detection of a method may be defined as the smallest concentration of a determinant for which we can be 95% confident that the determinant will be detected by a method. In order to determine the limit of detection, a calibration equation was obtained from a calibration

experiment where there was a linear relationship between the variables throughout the range of concentrations in the experiment and this relationship holds even as very low concentration. As shown in Figure 11a, a linear regression line, which passed through the origin, were obtained.

Before the determination of the limit of detection, it is necessary to define a criterion of detection, which is the corrected reading for a determination, above which we will be confident of the presence of the substance that we hope to detect. In this analysis, the actual concentration of surfactants may be defined as the criterion of detection.

The absorbance was then plotted against the actual concentrations in order to obtain calibration curve. The calibration equation from this graph indicates a linear relationship with the regression line intercepted above or below the y axis (Figure 11b). Computation of the regression statistics yielded the standard error from which the limit of detection can be calculated as shown.

$$Y_{LOD} = Y_B + 3 S_B$$

$$X_{LOD} = (Y_{LOD} - a) / b$$

Where LOD = Limit of Detection

X_{LOD} = Limit of Detection for concentration of SLS

Y_{LOD} = Limit of Detection for absorbance

S_B = Standard Error

Y_B = Intercept

a = Intercept

b = X variable 1

The limit of detection of the quantitative analysis of sodium lauryl sulfate by spectrophotometric method is:

$$Y_{LOD} = Y_B + 3 S_B$$
$$= 0.138995699 + 3 (0.066988861)$$
$$= 0.339962282$$

$$X_{LOD} = (Y_{LOD} - a) / b$$
$$= (0.339962282 - 0.138995699) / 0.128593548$$
$$= 1.562304558$$
$$= 1.5628 \text{ ppm}$$

Table 15: Absorbance versus concentration of sodium lauryl sulfate standard

Concentration of SLS standard (µg/ ml)	Absorbance
0	0.0560
1	0.2740
3	0.5910
5	0.8500
8	1.1520
10	1.3830

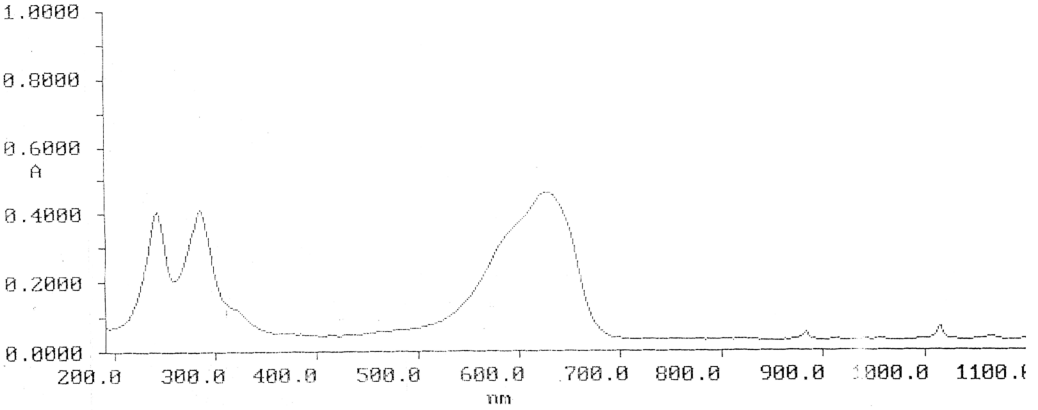

Figure 10: UV-visible spectrum of sodium lauryl sulfate

Figure 11a: Absorbance versus concentration of sodium lauryl sulfate standard

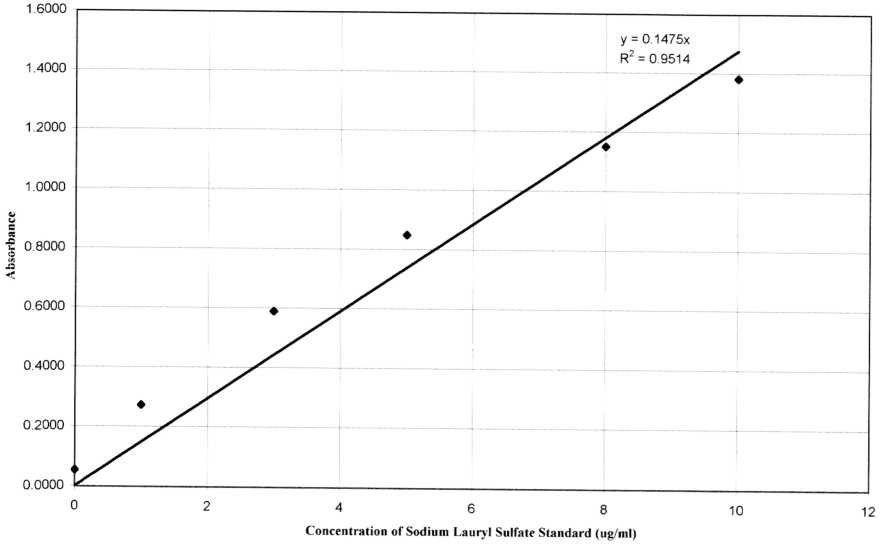

Figure 11b: Absorbance versus concentration of sodium lauryl sulfate standard

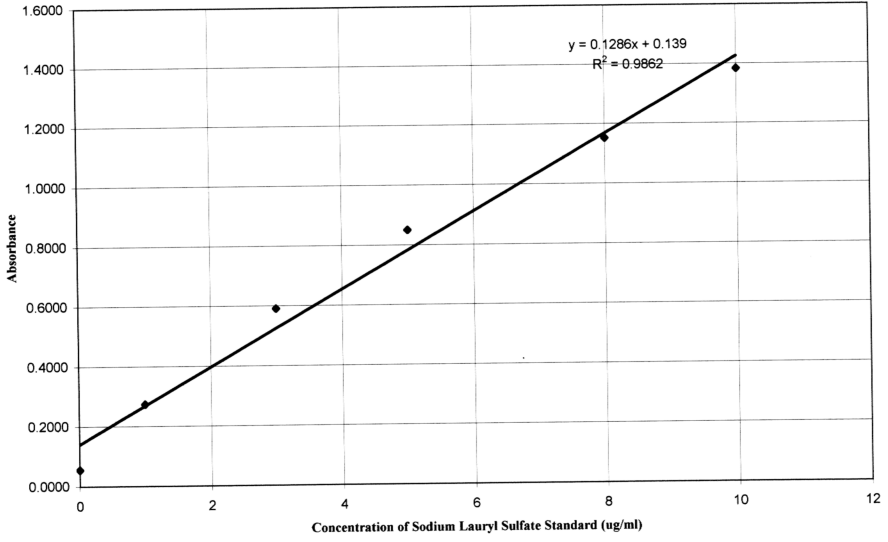

Table 16: Determination of sodium lauryl sulfate in some detergent products by spectrophotometric method

No.	Sample	Analysis 1						
		Absorbance			Conc. Of	SLS (ug)	Sample	SLS (%)
		Blank	Sample	Net	SLS (ug/ml)		(ug)	
1	Max Kleen 9 dishwasher	0.063	1.661	1.598	10.8339	541.695	80004	0.6771
2	Sunlight dishwasher	0.068	1.816	1.748	11.8508	592.544	80010	0.7406
3	Dynamo detergent	0.069	1.300	1.231	8.3458	417.288	80002	0.5216
4	Eeko detergent	0.063	0.318	0.255	1.7288	86.441	80000	0.1081
5	Dettol handsoap	0.060	0.757	0.697	4.7254	236.270	80010	0.2953
6	Kiwi floor cleaner	0.079	0.279	0.200	1.3559	67.797	80001	0.0847
7	Glassex glass cleaner	0.086	0.269	0.183	1.2407	62.034	80016	0.0775
8	Ajax fabuloso floor cleaner	0.085	0.144	0.059	0.4000	20.000	80010	0.0250
9	Jiff cleaner	0.061	0.102	0.041	0.2780	13.898	80006	0.0174
10	Amway liquid organic cleane	0.065	0.089	0.024	0.1627	8.136	79981	0.0102
11	Harpic toilet cleaner	0.071	0.084	0.013	0.0881	4.407	80008	0.0055
12	Prokleen cleaner	0.069	0.083	0.014	0.0949	4.745	80014	0.0059
13	Magic clean cleaner	0.074	0.094	0.020	0.1356	6.780	80018	0.0085
14	99 car wash cleaner	0.077	0.083	0.006	0.0407	2.035	79990	0.0025

Table 17: Determination of sodium lauryl sulfate in some detergent products by spectrophotometric method

No.	Sample	Analysis 2						
		Absorbance			Conc. Of	SLS (ug)	Sample	SLS (%)
		Blank	Sample	Net	SLS (ug/ml)		(ug)	
1	Max Kleen 9 dishwasher	0.060	1.584	1.524	10.3322	516.610	80010	0.6457
2	Sunlight dishwasher	0.062	1.841	1.779	11.6407	582.034	80012	0.7274
3	Dynamo detergent	0.072	1.265	1.193	8.0881	404.408	80006	0.5055
4	Eeko detergent	0.068	0.310	0.242	1.6407	82.035	80007	0.1025
5	Dettol handsoap	0.060	0.768	0.708	4.8000	240.000	80016	0.2990
6	Kiwi floor cleaner	0.072	0.276	0.204	1.3831	69.155	79990	0.0865
7	Glassex glass cleaner	0.077	0.256	0.179	1.2136	60.680	80023	0.0758
8	Ajax fabuloso floor cleaner	0.079	0.141	0.062	0.4203	21.015	80016	0.0263
9	Jiff cleaner	0.063	0.102	0.039	0.2644	13.220	80008	0.0165
10	Amway liquid organic cleane	0.066	0.088	0.022	0.1492	7.458	80012	0.0093
11	Harpic toilet cleaner	0.069	0.082	0.013	0.0881	4.405	80006	0.0055
12	Prokleen cleaner	0.063	0.077	0.014	0.0949	4.745	80018	0.0059
13	Magic clean cleaner	0.074	0.096	0.022	0.1492	7.460	80000	0.0093
14	99 car wash cleaner	0.077	0.084	0.006	0.0475	2.375	80007	0.0030

Table 18: Average value of % sodium lauryl sulfate in the 14 samples determined by spectrophotometric method

No.	Sample	Analysis 1 SLS (%)	Analysis 2 SLS (%)	Average % SLS	Repeatability (%)*
1	Max Kleen 9 dishwasher	0.6771	0.6457	0.6614	4.7475
2	Sunlight dishwasher	0.7406	0.7274	0.7340	1.7984
3	Dynamo detergent	0.5216	0.5055	0.5136	3.1350
4	Eeko detergent	0.1081	0.1025	0.1053	5.3181
5	Dettol handsoap	0.2953	0.2990	0.2972	1.2452
6	Kiwi floor cleaner	0.0847	0.0865	0.0856	2.1028
7	Glassex glass cleaner	0.0775	0.0758	0.0767	2.2179
8	Ajax fabuloso floor cleaner	0.0250	0.0263	0.0257	5.0584
9	Jiff cleaner	0.0174	0.0165	0.0169	5.3571
10	Amway liquid organic cleaner	0.0102	0.0093	0.0098	9.2210
11	Harpic toilet cleaner	0.0055	0.0055	0.0055	0.0000
12	Prokleen cleaner	0.0059	0.0059	0.0059	0.0000
13	Magic clean cleaner	0.0085	0.0093	0.0088	8.9888
14	99 car wash cleaner	0.0025	0.0030	0.0028	18.1818

* The repeatability of the determination is calculated by dividing the difference between the results of 2 determination carried out on the same sample simultaneously or in rapid succesion by the same analyst using the same apparatus by average

Table 19: Linear regression analysis of calibration graph

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.993069541
R Square	0.986187114
Adjusted R Square	0.982733892
Standard Error	0.066988861
Observations	6

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.281563303	1.281563303	285.5846582	7.18805E-05
Residual	4	0.01795003	0.004487508		
Total	5	1.299513333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.138995699	0.043823056	3.171748221	0.033801142	0.017323138	0.260668259	0.017323138	0.260668259
X Variable 1	0.128593548	0.007609423	16.89925023	7.18805E-05	0.107466359	0.149720738	0.107466359	0.149720738